

# The implementation of a Host-neutral Distributed Antenna system at ANL

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# Whatsa distributed antenna system?

- The term "distributed antenna system" (shortened to "DAS") generally refers to the infrastructure installed in a building intended for bidirectional broadcast of radiofrequency (RF) signals. Although the term DAS is general and may refer to a system designed to enhance the coverage of WiFi or portable radios, the primary application for the DAS at Argonne (and most other places) is to propagate cellular signals inside of buildings that lack reliable coverage.

# First, some facts about mobile phones:

- They're everywhere...
- In large quantities.
- We're hopelessly addicted to them...
- To the extent that **violence** erupts when they cease to work...

Source: The Derek Steinkamp Institute of Broad Statements Represented as Facts



# COVERAGE IS EVERYTHING!

- THE SKY IS BLUE!
- THE GRASS IS GREEN!
- THE POPE IS CATHOLIC!
- BEARS POOP IN THE WOODS!
- Etc.

Source: The Derek Steinkamp Institute for the Advancement of the Obvious



# Some backstory...

This is Argonne:



# More backstory...

- ~1500 acre site, surrounded by ~4500 acres of forest preserve
- 30 minute drive from Chicago
- ~100 buildings of various vintage
- 3500 FTEs, with 30,000++ visitors annually

These are just a few of the factors working **against** us...

# Is location everything?

- **Compared to other DOE locations**, Argonne would be called “tiny” and “urban”
- **On paper**, both of these traits appear to be advantageous when it comes to cellular coverage:
  - Small places are easier to cover with RF than large tracts of land
  - Densely populated areas typically have the most robust cellular networks, as they have the most customers
- **In reality**, the forest preserve is effectively acting as a buffer of just the right size; pushing all cell towers just beyond our reach. (more on this in a minute)
- **Outdoor coverage** is adequate, but going outside to use your phone gets old fast (especially in winter)



# Well, let's just have them put a cell site on our site!

- The most obvious solution to our coverage conundrum!
- In 2005, Sprint/Nextel installed an iDEN (Nextel) base station on a water tank in the middle of our site.





# Problem solved?

- The on-premise tower really did give us a shot-in-the-arm with regard to coverage, both indoor and out.
- Nextel, which operates in 800-900MHz, was pretty good at penetrating most site buildings.



# Once you give them a taste, they just want more...

- Once people got used to the idea of a mobile phone working on site again, they began to ferret out places where coverage was lacking.
- Once again, Sprint stepped up to the plate and installed a dozen or so bi-directional amplification systems in several buildings to supplement coverage in basements/services floors.
- They even went as far as to install a single-carrier DAS at the Advanced Photon Source, our largest user facility and biggest (sq.ft.) building:



# But then the IRS got in the way...

- An old IRS regulation stipulated that any personal call made by an employee on his/her company owned phone was a form of compensation, and thus taxable income (paraphrasing)
- This freaked out the accountants.
- And consequently, in the summer of 2009, Argonne moved from a corporate-liable model for cell phones to an individual-liable model



# Huh?

- Our Sprint/Nextel installation (and all its accouterments) was tied directly to the average unit count on our corporate contract staying at around 800 units/month
- Moving from corporate-liable to individual-liable took away the **sole bargaining chip** in our possession: \$subscriber count!

# It all comes down to the Benjamins...

- Average cost of a greenfield macro cell site install is \$500,000 - \$750,000
- Carriers look at two things when developing their macro-site build out plan:
  - The potential to gain new \$ubscribers
  - The potential to retain current \$ubscribers
- **Both of these points of appeal were thrown out the window by moving to the individually-liable model**

# It gets worse...

- Not only had this decimated any collective bargaining power we once had, but it also made us totally lose insight into our mobile user population.
- We now had no idea of the carrier demographics of our users
- This makes it exponentially more difficult to convince a cellular company that they should spend a cool half-million deploying a base-station on your site.



# And worse...

- In 2007, Apple released a little device called the iPhone.
- iPhone was AT&T-only its first 4 years.
- Sprint's phone lineup at the time was getting more and more anemic
- People now receiving stipends exercised the freedom to move to the carrier/device of their choice.
- In doing so, the coverage problem started brewing...
- **Carriers told us outright that it was not economically viable for them to build further macro-sites on our property.**
- Despite all of this, Sprint added CDMA and WiMax sectors to the tower (Thanks!!)



# Back to the drawing board...

- Knowing that the likelihood of getting additional carriers' macro sites colocated was "zero", we searched for alternatives:
  - Unlicensed Mobile Access (UMA)
  - Voice-over-WLAN via SIP
- Neither of these were a robust replacement for cellular.
- Carriers will occasionally build you a DAS on their own dime (like Sprint had done), however they will not foot the bill for the propagation of other carriers' networks.
- We knew that multi-carrier DAS was an option, but it was also the most expensive option.
- We're cheap, and since Sprint had built us a tower, we still could not accept the fact that others should not to the same, in spite of all the previously mentioned points. **We were in denial.**

# The DAS business model meets the public sector

- DAS is traditionally deployed in public venues (shopping malls, stadiums)
- In these locations, there is a large, constantly-changing user population that the cell companies want to keep happy.
- In these cases, the property owner typically foots the cap-ex of the system, and **cost-recovers by charging rent** to cell carriers. Yes, you read that right.
- In .Gov space, not only can we not charge rent, but our site population is small, has little variance in magnitude, and is mostly pretty static (i.e. the same 3500 people on site-each day)
- This is much different, than say, a football stadium or airport.

# The squeaky wheel gets the grease

- We knew we needed host-neutral DAS, we just didn't know how to fund it.
- Everyone was unhappy with the lack of coverage. It became the #1 IT-related complaint. Not just from employees, but from researchers, contractors, visitors, scientists, and collaborators. It's like we were living in the 20<sup>th</sup> century all over again.

# And magically, some money showed up...

- Like all good things in government, funding for the DAS project showed up in Q4 of the fiscal year.
- We weren't sure we would have enough "runway" to get this thing off the ground, **but that should never prevent you from trying.**



# If we build it, will they come?

- Cell carriers won't even talk to you about plugging in to your DAS until you have a design finalized.
- Which really means you have to build the DAS and wait for them to come plug in.
- A rather significant risk to build infrastructure that could be underutilized—or worse: totally dormant.
- **No reason not to try...**



# How does DAS work?

- A campus-wide DAS consists of 3 primary components:
  - Signal sources
    - Off-air repeater
    - Base Transceiver Station
  - Site distribution framework
    - DWDM single-mode fiber optic
    - Less than 3 dBo link loss
  - Building propagation framework
    - Amplifiers, coax, antennas

# Outsourced, of course!

- We do not have RF engineering expertise in-house.
- In order to maximize our return, we were able to re-purpose parts of the Sprint-only DAS installed at APS.
- Due to time constraints and desire for overall clean execution, we engaged Rizzo Consulting Inc., as our DAS contractor.
  - Rizzo had installed the original Sprint system, thus had familiarity
  - Most recently, Rizzo did the DAS at the Superbowl



# Fast Forward

- Project Kickoff 2011-8-6
- Project complete 2011-9-30
- 2,500,000 square feet in scope
- Cost is roughly \$0.40 per square foot
- 7 months later, Sprint still only carrier on-air

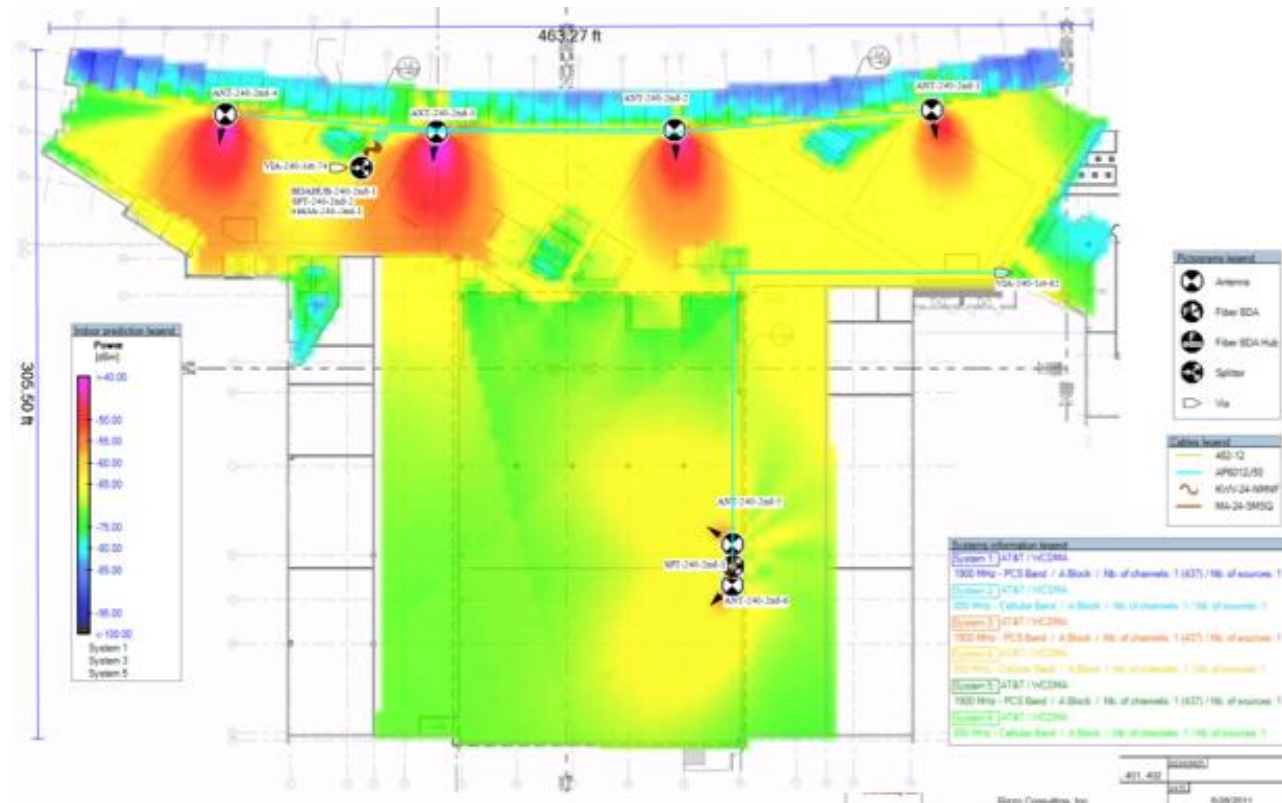


# Hints for a successful DAS deployment

- ENGAGE YOUR CARRIERS EARLY. THERE IS NO SUCH THING AS TOO EARLY.
- Avoid asbestos
- Avoid classified areas

# Tomorrow and Beyond

- Continue carrier integration
- Expand coverage footprint
- Add LTE



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